[SH22B-02] Eruptive Events at 30.4 nm: A Larger Sample from *SOHO* EIT

J.B. Gurman
NASA Goddard Space Flight Center
Laboratory for Astronomy and Solar Physics

Abstract. Although the SOHO Extreme ultraviolet Imaging Telescope (EIT) is normally used to monitor the full disk at 19.5 nm with a 12-minute cadence, we make use of occasional opportunities to observe in the He II Ly α resonance line at 30.37 nm (with some contribution from Si XI 30.34 nm) at a somewhat higher cadence. At the current phase of the solar cycle, this affords us the opportunity of amassing some statistics on various kinds of activity observable at 30.4 nm.

I report here on the limb activity visible in these data, including surges, sprays, eruptive prominences, jets, and two classes of phenomena which may not correspond to the classical H I Ba α nomenclature for eruptive events: loop jets and fan sprays. The former resemble flare sprays but appear to travel along pre-existing coronal loops, while the latter are not clearly associated with flares, and may represent a manifestation of coronal mass ejections at chromospheric temperatures.

I. Background

Tandberg-Hanssen (1974) describes three classes of ejecta, in addition to the *disparition brusque* :

- surges: material that appears to be constrained by the magnetic field as it erupts, with speeds of 100 – 200 km s^{-1}, and subsides;
- sprays: material that appears to break free from pre-existing fields (associated exclusively with flares), with speeds of 200 – 2000 km s^{-1}; and
- “fast ejections:” material accelerated to 500 – 2000 km s^{-1} in < 5 minutes

All these phenomena were observed primarily, perhaps exclusively, in Hα.

We know that some phenomena are easier to observe in He II 30.4 nm than in H α: *e.g.* macrospicules. This may be due to the material in such events being hotter than that in Hα features (either through the collisional excitation of the 30.4 nm line, or due to the fact that, as a resonance line, it can originate even in a population at higher temperatures than the ionization temperature of He II).

II. Motivation and Opportunity

It was clear from comparing *SOHO* EIT sequences of 30.4 nm images obtained at slower cadences (typically > 12 minutes) that there were fast, eruptive phenomena that were rarely captured in enough images (typically only one) to allow characterization of velocity or acceleration. Operational constraints (interleaving LASCO and EIT observations), however, rarely allow obtaining full-field, full-resolution images with EIT at higher cadences.

During the periods 1999 September 27 - October 4, 2000 January 8 - 14, and 2000 March 22 - 25, the *SOHO* spacecraft was subjected to a series of maneuvers as part of updating the onboard attitude control system (ACS) software to allow closed-loop attitude recovery without the use of gyroscopes. (All three gyroscopes on *SOHO* are useless since the readout electronics were damaged by exposure to extreme cold during the *SOHO* “vacation” of 1998 June - September.)

During these periods, the LASCO coronagraphs kept their doors closed to prevent contamination, so EIT was able to make use of the entire telemetry bandwidth normally used by both instruments. This in turn allowed us to run, most of the time at 6 - 7 minute cadence, extended time series of images in the

30.4 nm bandpass. This represents the maximum rate at which such images can be obtained, and requires the loan of the nominal SUMER bandwidth to LASCO and EIT (spacecraft telemetry submode 6).

The results reported here are from inspecting those time series, viewed as movies, and from attempting to categorize the eruptive events seen at the limb during those two periods of roughly 7.4, 6.4, and 4.0 days, respectively. Most of these data were full-resolution images, though at some times, the data rate was reduced due to spacecraft constraints.

III. Observations

Due both to a relative lack of sensitivity in the EIT 30.4 nm channel relative to the shorter-wavelength channels (cf. Delaboudinière *et al.* 1995) and the rupture of an internal Al filter in 1998 February that required the insertion of an additional Al filter in the light path *via* the EIT filter wheel, full-resolution images require exposure times of ~ 32 s. This necessarily blurs any features fast enough to move across more than one pixel during the exposure time. We therefore expect to see blurring for events with plane-of-sky speeds above (2.62 arc sec/pixel)(730 km/pixel)/32 s ≈ 60 km s^{-1}.

The three periods of observation were:

1999 September 27 10:30 UT – 1999 October 4 23:55 UT
2000 January 8 02:40 UT – 2000 January 14 11:48 UT
2000 March 22 22:48 UT – 2000 March 25 20:14

I have reported on the first two samples in an earlier work (*Bull. AAS*, **32SPD**, 32.0272G). Here, I extend the analysis and conclusions to the full, three-sample survey.

IV. Classification

We rejected all events that appeared clearly to be purely coronal (*e.g.* contamination from Fe XV 284 Å) in origin. Many of the events listed, however, may still arise partly or even primarily from Fe XV, Si XI, or second-order Fe IX, X emission.

Although we identified several subclasses, the primary groupings of eruptive events are well known from Hα and coronal observations:

- jets
- sprays
- surges
- coronal mass ejections (CME's), and
- true eruptive prominences (*e.g. disparitions brusques*).

In the three-sample survey, the *jets* (simple, relatively linear features, or *bifurcated jets*, characterized by bright edges and relatively dim center, or *loop jets*, in which usually bifurcated jets appear to travel along arcs defined by pre-existing loops) are the most common eruptive events (cf. Figure 3).

Loop jets appear to follow otherwise invisible coronal loops. It is possible that simple and bifurcated jets are loop jets seen from other aspect angles, but unlikely: the loop jets are confined to loop paths, while the simple and bifurcated jets often appear to escape or disappear entirely, rather than following the same path in subsiding. Peak plane-of-sky speeds for simple jets appear to be ~ 150 km s^{-1}. There is some uncertainty in determining speeds later in such events (typical lifetimes are ~ 7 – 35 minutes), simply because one does not know if the "leading edge" represents the same material, or just slower material. If the former, jets often show deceleration.

Sprays include the *fan sprays* (see Figure 1), which do not (to this author, at least) appear to correspond to any frequently observed Hα feature. The fan sprays in our sample typically began at plane-of-sky speeds of ~ 150 km s^{-1}, but appeared to accelerate further. Unfortunately, our limited field of view did not allow determination of later velocities.

Fan sprays do not appear to be associated with flares, and thus differ from Tandberg-Hanssen's definition of Hα sprays. Indeed, our "bright surges" are, paradoxically, more likely to be flare-associated.

IV. Statistics

Figure 2 shows the frequencies of the various denizens of the 30.4 nm eruptive zoo. As in the two-interval study, jets are the most common events, accounting for as many events as sprays and surges together in the three-sample survey. It should be noted, however, that even over periods as long as our roughly week-long runs, one or two active regions were responsible for most of the events of a given class. Similarly, the same one or two filament channels were responsible for all of the true eruptives in a given survey.

V. What's next

We need to measure the plane-of-sky speeds of as many of these events as we can, but realistically, *SOHO* EIT is less than ideal for capturing such events in a way that allows analysis of their dynamics. Instead, we need an EUV imaging telescope with:

- better throughput at 30.4 nm (to allow shorter exposures),
- a wider field of view (to allow following the eruptive events to greater radial distances, and determine whether they escape or decelerate), and
- more frequent images!

We trust that the SECCHI EUVI instruments on the two STEREO spacecraft will allow such observations.

It might also prove fruitful to examine H α prominence monitor data for some of the sample periods to determine the degree of correspondence between H α and He II features.

Acknowledgments

I would like to thank the LASCO/EIT ground crew, Kevin Schenk and Elaine Einfalt, for their help in obtaining these observations, and the LASCO team for allowing us these long, interrupted runs.

References

Delaboudinière, J.P. *et al.* 1995, *Solar Physics*, **162**, 291

Tandberg-Hanssen, E. 1974, *Solar Prominences*, D. Reidel, Dordrecht, The Netherlands, pp. 24 – 29